Impact of Stock Thinning and Relocation on Oyster Quality and Value — Dunk River, P.E.I. (Part 1 of 2)

R.E. Lavoie and C.F. Bryan

Invertebrates and Marine Plants Division
Resource Branch
Department of Fisheries and Oceans
Halifax, Nova Scotia

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IMPACT OF STOCK THINNING AND RELOCATION ON OYSTER QUALITY AND VALUE - DUNK RIVER, P.E.I. (PART 1 OF 2)

by

R.E. Lavoie and C.F. Bryan

Invertebrates and Marine Plants Division
Resource Branch
Department of Fisheries and Oceans
Halifax, Nova Scotia

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ABSTRACT

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Stock thinning of high-density oyster beds and oyster relocation on barren grounds were conducted in the Dunk River estuary in 1975 and 1976. The impact of these projects on oyster quality and standing value was studied during the two-year period following the operations. Stock thinning resulted in inconsistent quality improvements and increased the oyster standing values by percentages ranging from 12.9 to 24.5 during the first year following the operation. Oyster relocation produced important quality improvements and increased the oyster standing values by percentages ranging from 38.2 to 65.7 during the first year following the operation. Smaller quality improvements and value increases were recorded during the second year after relocation.

Key words: Oyster, management, density, quality, value.

RÉSUMÉ

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On a procédé, en 1975 et 1976, à l'éclaircissage d'huîtrières à peuplements denses et à la relocalisation des huîtres sur des fonds dénudés de l'estuaire de la rivière Dunk. L'impact de ces projets sur la qualité et la valeur des

huîtres a été étudié pendant les deux années qui suivirent les opérations. L'éclaircissage produisit des améliorations inégales de qualité et une augmentation de 12.9 à 24.5% de la valeur des huîtres dans l'année qui suivit l'opération. La relocalisation eut pour affet d'importantes améliorations de qualité et une augmentation de 38.2 à 65.7% de la valeur des huîtres dans l'année qui suivit. On enregistra, la deuxième année, de plus faibles améliorations de qualité et de valeur des huîtres.

INTRODUCTION

Summerside Harbour, Prince Edward Island, receives freshwater discharges from two rivers, the Dunk and the Wilmot. Within the estuaries of these rivers live the most productive populations of the American oyster (Crassostrea virginica) in the province of P.E.I.

In 1975, a joint federal/provincial oyster development project was initiated with a threefold objective: a) to increase the total area of oyster-producing bottom in Summerside Harbour; b) to improve oyster shell quality on natural beds by thinning the stock in overcrowded areas; and c) to improve the shell quality of the oysters relayed to new unpopulated grounds by separating clusters and spreading the relocated oysters at low densities. These quality improvement techniques are well known and have been recommended by several authors (Needler, 1941; Medcof, 1961; MacKenzie, 1975).

This report analyses the impact of the stock thinning and oyster relocation projects conducted in the Dunk River. First, it quantifies the quality changes recorded over a two-year period following the relocation projects conducted in 1975 and 1976. Second, it assesses the impact of stock thinning and relaying on the standing value of the oyster resource involved.

MATERIAL AND METHODS

The oyster bottom of the Dunk River contains areas of high oyster density. Fishermen usually disregard these areas as they produce clustered, poor quality oysters which require considerable culling and fetch lower prices.

Only the high-density areas were involved in the relaying projects. Their boundaries were first ascertained by SCUBA divers and the standing stock evaluated before individual quotas were calculated. The quotas to be relayed were kept under 30% of the estimated standing stock since it was felt a more drastic density reduction might affect reproductive success and result in a reduced oyster set. The donor areas from which the oysters were relayed are hereinafter called "giving grounds" and are accompanied by a value which is the calendar year during which oysters were relayed from them. For example, "DG75" means that area in the Dunk River estuary from which oysters were relayed in 1975.

The areas to which oysters were relayed are called "receiving grounds," and they are normally referenced by the calendar year value during which they received oysters, e.g. DR76. They were also selected by SCUBA divers who ensured that the bottom was firm enough to allow oysters to grow a desirable shell and that the water was deep enough at low tide to avoid potential ice damage during the winter. Receiving grounds did not bear any significant amount of oysters before the relaying operations.

The contours of the natural oyster bed and the giving and receiving grounds of 1975 and 1976 in the Dunk River are shown in Figure 1.

The high-density areas were surveyed in late July, after closure of the spring fishery, to determine oyster density and standing stock.

Sampling was done by throwing a 1 m^2 grid over the side of the boat and having a diver collect oysters, shells, and other material present within the grid. Collection was continued until all live oysters had been removed from within the grid. Sampling intensity ranged from 1:5,171 to 1:11,635.

Laboratory treatment of the samples first involved sorting of oysters from other shellfish, shells, and other bottom material. Length measurements of all oysters were taken with a caliper along the longest axis of the shell. All live oysters born during the years anterior to the survey year were measured. Spat of the year was disregarded.

Oysters of all sizes were tonged and culled by the fishermen and relayed immediately to the designated receiving areas.

Every second day the catch of 20 or more fishermen was sampled. Size frequency and quality were determined separately for market-size oysters (> 7.5 cm; 3 inches) and pre-market oysters (> 6.35-7.5 cm; 2.5-3 inches) to determine whether pre-market oysters reacted differently to relaying. Samples were also taken one year and two years after the stock thinning and relaying operations using tongs and drags to assess quality changes.

Operation-related oyster mortality on the giving grounds and on the receiving grounds was determined in mid-October following the relaying operations. Oyster samples were collected with tongs and drags. Dead oysters with the upper valve still attached, clean interior, and signs of either shell damage or smothering in mud were counted and presumed killed as a result of the relaying operation. These

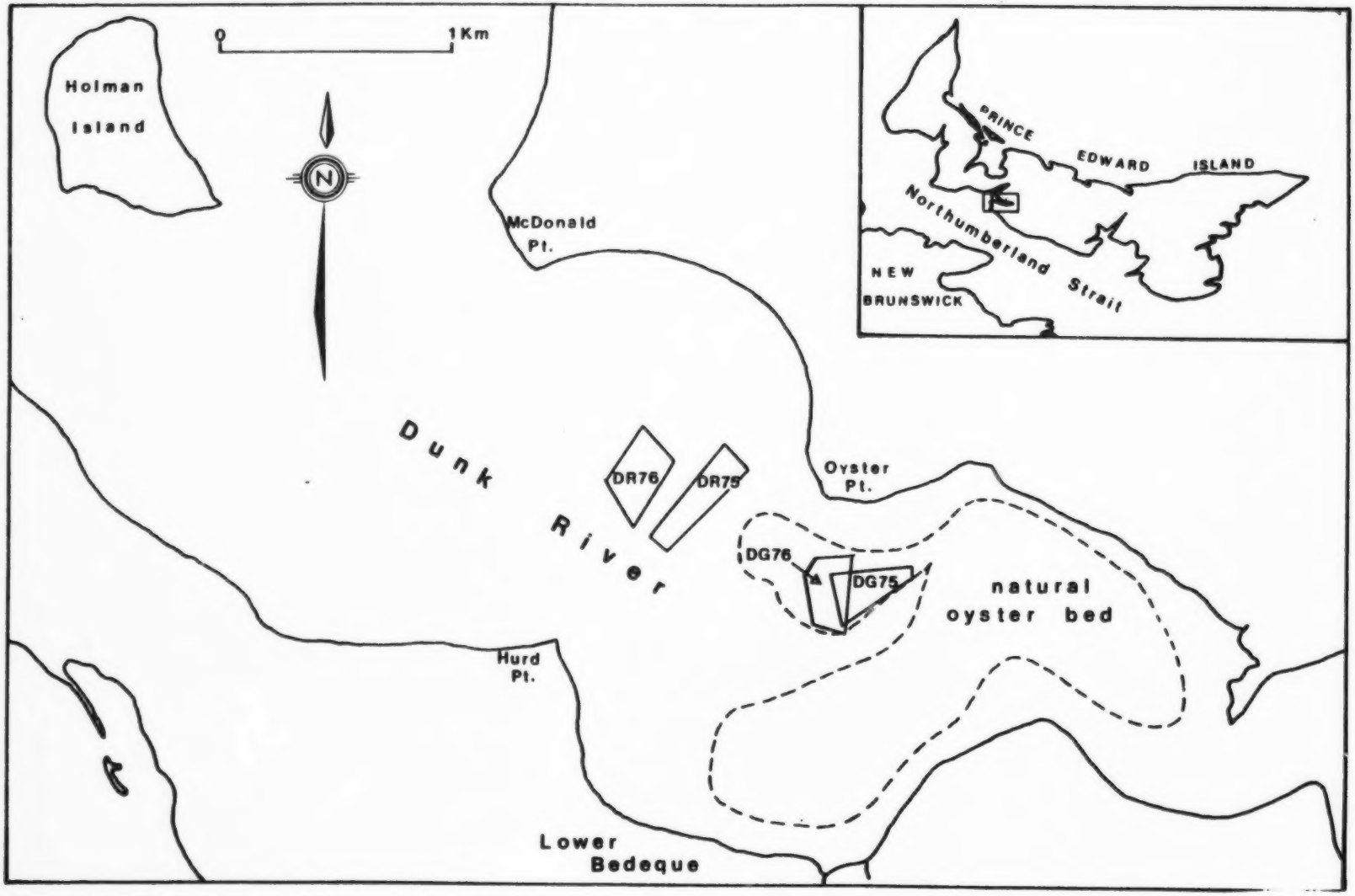

Fig. 1. Location of the 1975 and 1976 giving and receiving grounds in the Dunk River estuary.

determinations are probably fairly accurate as the giving grounds were not fished commercially prior to the stock thinning and the receiving grounds were barren prior to the relaying operation.

Oysters were separated into the Choice, Standard, and Commercial grades commonly used by DFO Inspection Division, and defined as follows:

Choice - The length of the oyster does not exceed one and three-quarters times its greatest width. The oyster is not abnormally flat, thin-lipped, or malformed.

Standard - The length of the oyster does not exceed twice its greatest width. The oyster is not abnormally flat, thin-lipped, or malformed.

Commercial - The oyster does not meet the requirements of Choice and Standard grades.

The grades are based entirely on shape, and meat quality is not taken into account.

An abnormally flat oyster is an oyster which has little depth to its shell, as compared to a cup-shaped oyster and, as a result, contains less meat.

A thin-lipped oyster is one on which the lip is so thin (this is generally new growth) that the handling and/or packing and shipping will invariably break the lip and allow the liquid to escape. This results in a dry or dead oyster on arrival at the market. These are not accepted for any shape.

A malformed oyster is one having a twisted or crooked shell which results in a poor appearance and difficulty in opening.

The initial quality breakdown (Q_0) obtained when the stock thinning and relocation was conducted was later compared with quality breakdown obtained on the giving and receiving grounds after one year of growth (Q_1) and two years of growth (Q_2).

Statistical calculations were done by computer using the SPSS system (Nie et al., 1975). The significance of the differences observed between Q_0, Q_1, and Q_2 was tested according to the conservative Scheffe procedure (Kirk, 1968; Winer, 1971). The application of the arcsine transformation to the percentages (Sokal and Rohlf, 1969) did not alter the significance of the differences.

The results as they appear in the tables are the percentage quality breakdown recorded in the fall of the various years, i.e. after the year's growth is complete or nearly so. The figures connected by solid lines are part of homogenous subsets where the means of the first and last groups differ by less than the critical value for a subset of that size. Percentage not connected by a solid line are significantly different ($\alpha = 0.05$ or less); "n" is the number of oysters graded to obtain the percentage breakdown shown in the table.

QUALITY CHANGES ON NATURAL BEDS

The oyster stock thinning-relaying operations were conducted in August of 1975 and 1976. The locations of the giving grounds (DG75 and DG76) are shown in Figure 1.

1975 STOCK THINNING

The area of DG75 was 12.5 acres. The initial mean density was 418.6 oysters/m^2. The thinning operation removed 3.6 million oysters of all sizes and created a mortality estimated at 9.0% of the remaining stock, resulting in a post-operation mean density of 315.7 oysters/m^2.

The quality changes observed on the market-size and pre-market oysters left on DG75 after completion of the 1975 thinning operation appear in Table 1. Although the market-size figures indicate a higher proportion of Choice and Standard oysters in 1976 as compared to 1975, the increases were not statistically significant. The corresponding decrease in the Commercial grade was not significant either.

The pre-market figures show a non-significant increase in Choice oysters between 1975 and 1976. The Standard grade shows a significant increase, while the Commercial grade shows a significant decrease.

1976 STOCK THINNING

The 1976 operation involved a giving ground (DG76) of 12.0 acres. The initial mean density was 274.3 oysters/m^2. After removal of 3.6 million oysters of all sizes and a 10.4% mortality of the remaining stock, the final post-operation mean density was estimated at 179.9 oysters/m^2.

Table 1. Percentage quality breakdown of market-size and pre-market oysters on the Dunk River giving ground DG75 (1975-76) and DG76 (1976-77).

Quality	DG75		n		DG76		n	
	1975	1976	1975	1976	1976	1977	1975	1976
Market size:								
Choice	5.9	9.1	167	28	7.7	27.3	126	77
Standard	30.4	42.3	856	129	43.6	45.3	715	128
Commercial	63.7	48.6	1794	149	48.7	27.4	798	78
Pre-market:								
Choice	12.0	14.1	188	39	15.8	42.6	134	121
Standard	30.0	50.3	470	138	44.9	29.7	382	84
Commercial	58.0	35.6	909	98	39.3	27.7	334	79

The quality changes observed on market-size and pre-market oysters left on DG76 after completion of the 1976 stock thinning operation are quantified in Table 1.

In 1977, a significant increase in the proportion of market-size Choice oysters was recorded. The Standard grade showed a non-significant increase, while the Commercial grade showed a significant decrease. These results suggest that the Standard and Commercial oysters participated in a general upgrading movement following the stock thinning of 1976. The better Standard oysters moved up to Choice, while the better Commercial moved up to Standard, resulting in a non-significant increase in the Standard grade between 1976 and 1977.

The pre-market oysters showed a somewhat different quality upgrading pattern. The Choice grade representation almost tripled, while the Standard and Commercial grades both showed a significant decrease. These results suggest that a large proportion of the oysters which graded as Standard in 1976 graduated into the higher Choice grade during the 1977 growth season. A significant, although smaller, proportion of the oysters which were Commercial in 1976 graduated to Standard during the same period, resulting in a significant decrease in both the Standard and Commercial grades.

QUALITY CHANGES OF RELOCATED OYSTERS

The location of the Dunk River receiving grounds (DR75 and DR76) to which oysters from the giving grounds were relayed is shown on Figure 1.

The area of DR75 was 15.5 acres. A total of 3.6 million oysters of all sizes were relayed from DG75 onto this ground. A post-operation mortality of 27.5% was recorded for a final mean density of 41.9 oysters/m^2.

The area of DR76 was 15.0 acres. A total of 3.6 million oysters of all sizes were relayed from DG76 onto this ground. A post-operation mortality of 10.1% was recorded, for a final mean density of 52.9 oysters/m^2

The quality changes observed on the relocated market-size and pre-market size oysters are quantified in Table 2.

Both size groups showed large significant increases in the proportion of Choice oysters during the first year the relayed oysters were on new grounds. With one exception (market-size on DR76 between 1977 and 1978), small but still significant increases in the proportion of Choice oysters were observed during the second year on the receiving grounds,

Table 2. Percentage quality breakdown of market-size and pre-market oysters on the Dunk River receiving grounds DR75 (1975-1977) and DR76 (1976-78).

Quality	DR75			n			DR76			n		
	1975	1976	1977	1975	1976	1977	1976	1977	1978	1976	1977	1978
Market size:												
Choice	5.9	41.9	59.2	166	342	352	7.7	36.3	42.1	126	241	205
Standard	30.4	51.5	32.8	856	421	195	43.6	44.5	43.7	715	296	212
Commercial	63.7	6.6	8.0	1795	54	47	48.7	19.2	14.2	798	128	69
Pre-market:												
Choice	12.0	59.5	83.0	188	271	288	15.8	57.9	72.0	134	237	175
Standard	30.0	36.1	12.6	470	165	44	44.9	33.2	26.5	382	237	64
Commercial	58.0	4.4	4.4	909	20	15	39.3	8.9	1.5	334	36	4

Conversely, large significant decreases in the proportion of Commercial oysters were observed during the first year after relaying in both size groups. The second-year decreases were all non significant.

These results show an important quality improvement of the oysters relayed on DR75. The proportion of market-size oysters in the top two grades went from 36.3% in 1975 to 92.0% in 1977, leaving only 8.0% of the oysters in the undesirable Commercial grade. The proportion of pre-market oysters in the top two grades went from 42.0% in 1975 to 95.6% in 1977, leaving only a negligible 4.4% of the oysters in the undesirable Commercial grade.

The oysters relayed on DR76 exhibited a similar improvement pattern. From 1976 to 1978 the proportion of market-size oysters in the top two grades went from 51.3% to 85.8%, leaving 14.2% of the oysters in the Commercial grade. The proportion of pre-market oysters in the two superior grades went from 60.7% in 1976 to 98.5% in 1978, leaving the Commercial grade almost non existent on DR76 at the end of the period.

IMPACT OF QUALITY CHANGES ON RESOURCE VALUE

The overall impact of the stock thinning and relocation project on the standing value of the oyster resource was assessed, using the prices paid by buyers to the fishermen as a standard. The value of the resource in dollars per metric ton was calculated on the basis of the quality breakdown at the time of the stock thinning and relaying operation and after one and two years of growth. Values are expressed in constant 1975 dollars for the 1975 operation and in constant 1976 dollars for the 1976 operation in order to eliminate distortions due to inflation and market factors. The prices paid for each grade in 1975 and 1976 appear in Table 3.

The standing values of market-size and pre-market oysters on the Dunk River giving grounds (DG75 and DG76) and receiving grounds (DR75 and DR76) are shown in Table 4. These figures demonstrate a substantial increase in value one year after the operation, both on giving and receiving grounds. The one-year increase in value was greater on the receiving grounds than on the giving grounds following both the 1975 and 1976 operations. The initial values of pre-market oyster were higher than those of the market-size oysters, a possible consequence of a lower negative impact of overcrowding on smaller oysters' quality.

Table 3. Prices paid for oysters of different quality in western Prince Edward Island in 1975 and 1976 in dollars/kg.

Grade	1975	1976
Choice	0.78	0.80
Standard	0.52	0.54
Commercial	0.26	0.28

Table 4. Standing value in dollars/metric ton of market-size and pre-market oysters on the Dunk River giving and receiving grounds, 1975-1978.

Ground	Year			
	1975	1976	1977	1978
Market-size oysters:				
DG75	369.72	417.56	-	-
DR75	369.72	611.78	653.12	
DG76		433.40	539.74	-
DR76		433.40	584.46	612.54
Pre-market oysters:				
DG75	400.40	464.10	-	-
DR75	400.40	663.26	726.36	-
DG76	-	478.90	578.74	-
DR76	-	478.90	662.00	723.30

The percentage value increases of market-size oysters from the initial value based on quality (Q_0) to one year after the operation (Q_1) to two years after the operation (Q_2) for the giving and receiving grounds appear in Table 5. These figures further demonstrate the superior gains by the oysters moved to the receiving grounds, compared with those left on the giving grounds. The receiving grounds' market-size oysters show large gains from Q_0 to Q_1 and Q_0 to Q_2. However, the gain from Q_1 to Q_2 as calculated on the basis of the resource value at Q_1 is rather small. Generally, pre-market oysters showed higher value improvements than market-size oysters between Q_0 and Q_1 and Q_0 to Q_2. This supports the hypothesis that higher quality-related value increases will result from relocating smaller oysters. Value increases from Q_1 to Q_2 were also larger than with the market-size oysters.

CONCLUSIONS AND DISCUSSION

After one year, the 1975 stock thinning had not produced a statistically significant increase in the quality of market-size oysters. A significant increase of the Standard pre-market oysters and a significant decrease of the Commercial group were recorded.

The 1976 stock thinning produced in one year a statistically significant quality increase of both market-size and pre-market oysters. One exception was the market-size Standard group which showed no significant change.

Both the market-size and pre-market oysters relayed to new grounds in 1975 showed significant Choice grade increases after one year of growth on their new grounds. A further significant Choice grade increase was recorded between 1976 and 1977.

Both the market-size and the pre-market oysters relayed in 1976 showed a significant Choice grade increase after one year of growth on their new grounds. The pre-market oysters had a further significant Choice grade increase between 1977 and 1978, while the market-size group showed a non-significant increase.

Market-size and pre-market oysters left on the natural beds after the stock thinning operations, and those relayed to new grounds, appreciated in value. The market-size oysters left on the natural beds after the 1975 operations showed the smallest first-year increase (12.9%), while the pre-market oysters relocated to new grounds in 1975 showed the largest first-year increase (65.7%).

Table 5. Percentage increases in value of market-size and pre-market oysters on the Dunk River giving and receiving grounds.

Ground	Growth period		
	Q_0-Q_1	Q_1-Q_2	Q_0-Q_2
Market-size oysters:			
DG75	12.9	-	-
DR76	65.5	6.7	76.6
DG76	24.5	-	-
DR76	34.9	4.8	41.3
Pre-market oysters:			
DG75	15.9	-	-
DR75	65.7	9.5	80.9
DG76	20.9	-	-
DR76	38.2	9.3	51.0

The pre-market oysters appreciated more in value than the market-size oysters, whether they were part of a thinned stock or of a relocated lot.

The largest value appreciation for relocated oysters took place during the first year of growth after the relocation. This suggests that it might be economically preferable to fish the oysters at Q_1 because natural mortality losses between Q_1 and Q_2 could easily equal if not surpass any gain attributable to quality improvements. The determination of the best point of fishing to optimize cost/benefit, however, involves not only timing but also other important factors. Growth will tend to increase the weight and volume of the standing crop with time while quality improvement will increase the unit value of that crop. On the other hand, natural mortality can easily remove 10-15% from the harvestable crop per year. One has to be balanced against the other.

The recovery rate defined as that proportion of the standing crop which the fishermen actually harvest needs investigation. Theoretically, the recovery rate should increase with oyster density, all other factors being equal. However, a point will be reached where increasing oyster density will limit individual growth and quality improvement. The optimal oyster density on the receiving grounds will maximize the recovery rate by approaching that point without quite reaching it. The resource loss associated with low recovery rates could be minimized if the same receiving grounds are utilized year after year, making the residual oysters part of the new standing crops created by subsequent relaying projects.

It is our opinion that determination of the best point of fishing and optimization of the recovery rate should constitute an important part of the research associated with future stock thinning and relaying projects in Summerside Harbour.

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